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MERRY CHRISTMAS TO ALL . .

AND TO ALL, A GOOD YEAR

Mecheleciv Staff

THE GEORGE WASHINGTON UNIVERSITY

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ARTICLES

DEPARTMENTS

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A HERO IS DEAD . . . .

AND THE PEOPLE KNOW IT

WE DEDICATE OURSELVES TO THOSE IDEALS

FOR WHICH HE STOOD:

TRUTH

JUSTICE

HONOR,

WISDOM,

PEACE,

AND FREEDOM.

FORTRAN for NONTECH's

by Joseph Russell Moulton, a SIGMA TAU ESSAY, 2nd Place

With the advent of the Electronic Data Processors (EDP) development into highly operational systems, an exciting new aspect to engineering has been opened to the engineer. The computer engineer, of course, is keenly aware of this fact; for in order to deserve the title, he has associated himself a great deal with computers. It is then the non-computer engineer who must make the effort to gain a basic understanding of the general purpose EDP so that these highly operational systems may be utilized to their fullest potential. An engineer who has had no association with EDP systems might ask the question, "what does an EDP system consist of?" The answer in the simplest form would be "a well chosen collection of software and hardware equipment". Software takes the form of punched cards or magnetic tape and provides the communication link between the engineer, his problem, and his problem's solution and the hardware equipment. The hardware consists of uniquely designed electronic equipment that has the capability of being ordered to perform such functions as; remembering communications it has received, performing mathematical manipulations such as addition, subtraction, multiplication, and division, and finally comparing or sensing for predetermined numerical values. When an engineer desires an EDP to perform an assignment for him, the first prerequisite is that the engineer be able to communicate with the machine. Communication implies a language of a form understandable to the parties communicating. The EDP knows only the language endowed to it by the computer designer, and this is known as the machine language. As would be expected, each of the various differently designed data processing machines has its own machine language. EDP's designed using digital techniques have as their machine language some form of binary code. The art of preparing communication or writing programs for a machine is called programming; and for the engineer to perform this, requires specialized training he has not usually had. In international political circles, this problem is overcome by a third party called a translator/interpreter. Here the solution is the same with the title given to the third party of programmer. A programmer is a person sufficiently skilled in both the engineer's and the machine's language so that he can perform the programming for the engineer. A successful attempt was made to ease the training requirement for the programmer by developing semi-universal languages that are easier to use than machine languages and could be utilized on most all available EDP's. The new language developed for the purpose of presenting scientific type problems to a machine is called FORTRAN. The word FORTRAN stands for "formula translation" and could be said to be a kin of the algebraic language used by engineers. There are other languages developed for ease in presenting other type problems to EDP's. An example would be COBOL which is used for commercial problems. As was stated earlier, each machine can accept communication only in its own machine language. For a machine to understand FORTRAN, it is necessary first to write one program in machine language explaining how to convert FORTRAN language to machine language. This program is part of the software equipment furnished with general purpose EDP's as well as other language conversion programs. This software equipment is referred to as the compiler. Thus, if the engineer has a general understanding of FORTRAN, he will also know the type of problems he can allocate to the computer, and at the same time be better prepared for formulating his problems for the programmer. A FORTRAN program consists of a series of statements, each of which orders the machine to perform one or a combination of its capable functions. An example of a statement which might appear on a FORTRAN program is:

```
Y = Y + 2.0
```

Somewhere in the machine's memory area, it has stored a value of Y. The statement above orders the machine to replace the old value of Y with Y plus 2.0. One can see the similarity to algebra with the major difference being the symbol "=" means "to replace" in FORTRAN instead of "equals" as in algebra. The symbol "+" means to add 2.0 to Y just as it does in algebra. The basic arithemetic operations that can be performed and their FORTRAN symbols or binary operators as they are called, are listed below.

A + B means A plus B
A - C means A minus C
A * X means A multiplied by X
Y/Z means Y divided by Z
X**Y means X^Y
A**2 means A^2

In FORTRAN, constants are separated into two categories which are integer constants and floating point constants. Floating point constants are specified with a decimal point, whereas, integer constants are not. Similarly, variables are divided into integer variables and floating point variables. In general, variables are names consisting of one or more letters and/or numbers up to a maximum of 6 characters for most computers, but 5 for the IBM 1620, and the first of which must be alphabetical (A-B). Variable names starting with the letters I, J, K, L, M or N are integer variables. All others are floating point variables, with the restriction that no variable may end with the letter F. Variables are usually selected so as to provide meaning, i.e., for temperature one would probably select the variable name "TEMP" if using as a floating point and as say, "JTEMP" if using as an integer. One may subscript integers or floating

point variables; and the subscripts may be constants, variables or arithmetic expressions, but all subscripts must be of the integer mode as against the floating point mode and whose numerical value may never be zero or negative. No statement in the program may contain a combination of integer and floating point constants/variables; and to do so is referred to as mixed mode. The last example in the previous list refers to the only permissible mixed mode situation.

Some of the common types of FORTRAN statements will be typified by the following program to solve the problem of e^x to 6 decimals where x goes from 0.1 to 1.0 in steps of 0.1. Expanding e^x in series form yields,

$$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots + \frac{x^n}{n!}$$

$$e^x = 1 + \sum_{i=1}^{n} \frac{x^i}{i!} = SUMEX$$

Let: $x = \left(\frac{JX}{10}\right)$

$$A(i) = x^i = \left(\frac{JX}{10}\right)^i$$

$$B(i) = i!$$

Then:

$$SUMEX = 1 + \sum_{i=1}^{n} \frac{A(i)}{B(i)}$$

with an i^{th} X-term $= \frac{A(i)}{B(i)}$

Statement No.	Statement	Meaning
1	Dimension A(50), B(50)	Reserve 50 memory storage areas for subscripted variable A & B.
5	Do 36 J = 1, 10, 1	Repeat the statements which follow, through and including the one labeled 36, each time varying J from the initial value of 1 in increments of 1, until the condition J > 10 is reached; then transfer control to the statement following No. 36.
9	XJ = J	This gets the value of J into floating point.
10	SUMEX = 1.	This starts the sum of e^x after the first term of the series expansion.
11	A(I) = 0.	This starts A(I) at zero.
12	B(I) = 1.	This starts B(I) at one.
13	XTERM = 0	This starts XTERM at zero.
14	I = 0	This starts I at zero.
18	I = I + 1	This increments I by one each time statement 18 is executed.
19	ZI = B(I)	Preparation for operation to be performed in statement 22.
20	XI = I	Same reason as statement 9.
21	A(I) = (XJ/10.) ** I	This is the value of numerator for Ith term in series.
22	B(I) = XI * ZI	This is the value of denominator for Ith term in series.
23	SUMEX = SUMEX + A(I)/B(I)	This is the value of the series progressed thru the Ith term.
24	XTERM = A(I) /B(I)	This is the value of the Ith term in the series.
25	If (XTERM - .000001) 30, 30, 18	This means if the present value of the XTERM minus .000001 is negative or zero, go to statement 30; if positive, loop back to statement 18 and repeat from that point.
30	PRINT 4, J, SUMEX	Print out the value of J and SUMEX in the form stated in statement 4.
36	CONTINUE	
4	FORMAT (I3, 5X, F10.6)	This tells machine the spacing and decimal form for print out.
40	STOP END	Tells computer the program has been completed.

It should be noted that although every item on the preceding program was numbered, it is not necessary; and, in fact, one should number only statements which are required for identification by the machine. For example, here one should only have numbered 4, 18, 30 and 36. Notice also, one need not number statements consecutively.

It is apparent that no two programs would be identical for the same problem if written by two different programmers and of course they need not. The main criteria is that the program be correct and not require excessive machine running time. Most usage of machines is on a rental basis; and when a program entails more machine time than is necessary, it can greatly increase the cost of the problem solution.

LETTER TO THE EDITOR

The trend among the engineering students at the George Washington University is a good one! I have been around here for about six years and have noticed its development. Others -- students and professors alike -- have also observed its growth. One professor last year spent an hour discussing its importance with his class. You hear it being discussed often when the engineers get together for an informal talk.

What is this trend?

In contrast with an almost universal and often trifling depreciation of their schools by university students throughout the country, we engineers are experiencing an increasing pride in ourselves and our school. And we have good reason. We have an excellent school and instructors; and what is probably even more important, we have excellent students.

Look around you, and you will see what I mean. There are few you aren't proud to associate with. Most have been screened thoroughly by our admittedly rugged curriculum and are dedicated to the spirit of a very honorable profession. It is not always easy, but we are not here to be spoon-fed by our instructors any more than we expect to be nursed by our future employers.

And we are beginning to become more aware that it means something to have made the grade here. With increasing frequency, we are hearing how our alumni are and have been earning high professional respect on the "outside."

This pride results in a mature sense of responsibility to ourselves and our school. In a very real sense, we become more dedicated to what our profession expects of us, now and in the future.

SIGMA TAU

On Saturday, 16 November 1963, ten of our better students were honored by being initiated into Sigma Tau National Engineering Honorary Fraternity. Those received into the organization were:

Shanti P. Chakravarty	EE
Malcolm Costello	CE
Walter Crater	EE
Ely Fishlowitz	ES
Francoise Fougerat	EE
Abdul Heideri	EE
Philip Kaplan	EE
Jean Lavanceau	EE
Judith Popowsky	ME
Vytas Tarulis	EE

After the ceremonies, the new members were given their certificates and keys at a luncheon held at the Black Saddle.

Three candidates were unable to attend the initiation. They will be initiated at a later date. They are:

Robert Dunn	EE
Joseph Moulton	EE
Dillon Scofield	EE

TAU BETA PI

On Sunday, November 24, 1963, three outstanding members of the engineering student body were initiated into Tau Beta Pi:

Walter Crater	EE
Philip Kaplan	EE
Thomas McIntosh	ME

Although a luncheon was scheduled for that afternoon, the function was cancelled in deference to President John Fitzgerald Kennedy's death.

COMING

FEBRUARY 29, 1964

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RICHARD
STRETTON
BAND

PROFESSOR HIGHLIGHTS

Dr. Louis dePian

Dr. dePian came to The George Washington University in 1957. He received his bachelors degree, in both mechanical and electrical engineering, from the National Technical University of Athens, Greece, and his Masters and Ph.D. degrees in electrical engineering from the Carnegie Institute of Technology. He holds membership in Alpha Kappa Nu, Sigma Xi, and Tau Beta Pi Honorary Fraternities. He has held a teaching position at the Carnegie Institute. And he now holds the position of being one of the most outstanding engineering professors at the School of Engineering and Applied Science.

Dr. dePian has an unusual philosophy of teaching. Perhaps it can be summed up by his famous quote: "I don't like to lecture, but I do like to teach." He, therefore, attempts to eliminate as much straight lecturing as possible from his classes. Since he feels that normal lecture patterns are simple repetitions of text material, he encourages students to read the text and to ask questions regarding any material which confuses them or which arouses their curiosity. When such questions are asked, Dr. dePian does his utmost to expand upon the subject with topics which are not covered in the text. This type of teaching, Dr. dePian believes, challenges the student and encourages him to learn on his own. To go along with this method, at the end of the semester he offers an oral exam. This exam would count as the student's entire grade. The idea is to aid those students who freeze on written examinations, and to offer a means of proof to those students who believe that they know more about the course than their grades show.

However, Dr. dePian does not occupy all of his time with teaching. He has already had one book published, and is currently writing another. He is also working on a research contract with the Public Health Service, where he is doing research in the field of electro-cardiography. Besides, he is also conducting independent research in the field of network theory.

DANGER: ELECTRIC SHOCK

This is the top prize winning essay in the SIGMA TAU PLEDGE ESSAY contest.

by Jean D. Lavanceau

You probably have experienced that putting your fingers (inadvertently, mind you) across the battery terminals of your automobile, touching some bare wires in a radio receiver or television set (the ones you knew could be fixed by yourself), fishing for that smoking slice of bread stuck in your toaster (in the early hours of the morning while you are -- were -- still half asleep), or in general, poking around the myriad of electrical gadgets and equipment where voltages are present, does sometimes hurt -- and how--! Later on, bragging about your misfortune, you scientifically explain that you took a discharge (should perhaps be called a charge and your immediate verbal reaction a discharge) of X^n of those things called volts. You were the lucky one, of course, for in this country alone, it is estimated that about 1,000 of our citizens die every year as a consequence of the effects of electrical shocks, and that thousands of others suffer serious injuries.

Yet, then, how much "voltage" can we come in contact with without getting seriously hurt or killed?

In an attempt to answer this question, it must be pointed out that in electrical shocks the voltage and the impedance of the circuit (of which the human body becomes an involuntary but, nevertheless, integral part) are the two parameters, which, if one believes OHM's law, determine the intensity of the current which flows through that circuit. It is the value of this current rather than the voltage that is the determining criterion of the physiological effects of electrical shocks. This impedance circuit is variable and is a function of the location of the "contacts" across which the voltage source is applied, as well as the nature of the resistance between those contacts. As an illustration, an electrical potential applied between the right hand of Mr. Jones and a concrete floor on which Mr. Jones is standing will cause a current to flow through him which will have an intensity dependent upon whether he is wearing heavy rubber sole shoes or is barefooted. In the first situation, Mr. Jones may still say "hello" and smile, and in the latter, -- well, Mr. Jones may not be smiling any more. Concentrating now on the human body, it has been shown that the resistance that it opposes to an electrical current is somewhat equal to the resistance of the skin (or contact resistance) plus the resistance of the body itself (or the Human Body -- without the skin). The skin resistance plays a very important role for low voltage accidents, but loses any meaning for very high voltage "therapy" since it breaks down instantly. Further, the resistance of a wet skin is much lower than the resistance of a dry skin -- (but you knew about that).

Approximate total body resistance (from an average of few samples)

a. For a dry skin:
   From hand to feet:) 100,000 Ohms to
   From hand to hand:) 600,000 Ohms.
   From ear to ear:)

b. For a wet skin:
   From hand to foot (across chest): 1,400 Ohms to 1,600 Ohms
   From hand to hand: 1,200 Ohms to 1,500 Ohms
   From ear to ear: 1,000 Ohms to 1,200 Ohms

For the last two centuries, many experimental investigations and analyses of known electrical accidents have been made to determine the effects of electrical shocks on insects and animals (men included), the results of which, when applied to men, have led to the following conclusions:

1. The physiological effects of electrical shocks are a function of the magnitude of the current and of the path followed by the current.

2. An electrical current flowing through the heart may disturb the cycling action. Its magnitude may be such as to generate severe cardiac muscular contractions, causing a condition known as ventricular fibrillation of the heart. <u>This means death</u> if the condition exists for a period of time.

3. Ventricular fibrillation does not respond to resuscitation. The only known successful method of reviving the victim is by the application of high intensity shocks or countershocks, of short duration. However, this procedure requires special skill and equipment, and must be administered at once.

4. The threshold fibrillating current -- or minimum current likely to produce ventricular fibrillation -- is affected by the size of the body, the frequency of the current, the time of duration of the electrical shock, and the path followed by the current.

5. The heart is susceptible to ventricular fibrillation for approximately 20 percent of its cycle; therefore, electrical shocks of duration of 1/10 of a second are not likely to cause this condition.

6. Successive electrical shocks are not suspected to have a cumulative effect in regards to the ventricular fibrillation of the heart.

7. Currents of magnitude well above the fibrillating currents cause severe muscular contractions which clamp the heart and stop its cycling action for the duration of the shock. This prevents the ventricular fibrillation of the heart from happening. Severe electrical and/or thermal burns (generation of Lichttemberg figures) and serious damage to the nervous system may follow. The victim stops breathing for the duration of shock but may be revived if artificial respiration is administered immediately.

Fortunately, an individual experiencing large electrical current shocks may be saved by the violent muscular reaction which takes place, and which literally throws him out of the circuit.

The physiological effects of electric shocks, as a function of the intensity of a current flowing through the human body, and for a pathway including the chest, can be listed as follows:

A. Safe Current Values:

1 Milliampere or less: no sensation is felt.

1 Milliampere to 8 Milliampere: sensation of shock, caused by stimulation of the sensory nervous system. A tickling sensation is experienced, but muscular control is not lost and the individual can release grip at will.

8 Milliamperes to 15 Milliamperes: Painful shock, but muscular control is not lost and the individual can release grip at will.

A current having an intensity of one milliampere and a frequency of 60 cycles per second is considered to be the "threshold current of perception."

The above currents are sometimes called "let go currents" because the individual experiencing this type of electrical shock still retains muscular control and can release himself from the electrical circuit.

When the intensity of the current is above 15 milliamperes, the subject starts to lose muscular control and may therefore become incapable of freeing himself from the circuit unless muscular contraction plus a favorable position of his body in the electrical circuit causes a physical reaction which will break the electrical contact.

B. Unsafe Current Values:

15 Milliamperes to 20 Milliamperes: Painful shock. Muscular control is lost and the subject cannot release grip at will.

20 Milliamperes to 75 Milliamperes: Painful shock. Severe muscular contractions. Breathing becomes extremely difficult and might stop during the shock.

100 Milliamperes and above: Severe muscular contractions cause ventricular fibrillation of the heart. It is estimated that a current of 60 cycles per second, having an intensity of 100 milliamperes, for a time duration of 3 seconds or more, will bring about this condition.

The following table, which appeared in an article by C. F. Dalziel, shows the relation between current and the duration of the electrical shock which bring about ventricular fibrillation of the heart.

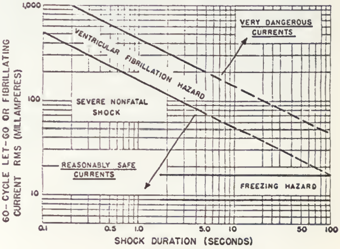


Fig. 1.

For Currents Above the Ventricular Fibrillation Threshold Current:

Severe burns. Violent muscular contractions clamp the heart, and stop its cycling motion for the duration of the shock. This prevents ventricular fibrillation of the heart. Contraction of the muscles of the respiratory system stops breathing action, but, if artificial respiration is applied

(Continued on page 17)

FUEL CELLS: TWO STEPS FORWARD

The fuel cell, which lay dormant for so long after its discovery more than a century ago, has in recent years found itself the object of optimistic attention. As the attention grew--and as the relevant technologies progressed--results began to accumulate. This spring some of the fundamentals of fuel cell science were surveyed in an informal talk presented by Dr. Herman Liebhafsky to an audience of his colleagues at the General Electric Research Laboratory. Some excerpts from that talk are presented below.

We have in the United States today what might fairly be called an emergent fuel cell industry. About $20 million a year of Government funds is going into the work, plus an estimated $5 million in private funds. With all this money being spent, it would be reasonable to ask why we don't have fuel batteries in commercial operation. I think there are two answers: over-estimated progress and underestimated complications.

As long ago as 1895, the public was being encouraged to believe that large-scale power generation by means of fuel batteries was practically around the corner. One illustration in Harper's magazine that year showed an artist's conception of a central station powered by fuel batteries, complete with a couple of street cars sitting patiently outside the station, no doubt waiting for the power to be turned on. If they had any passengers inside them, I hope they're not still waiting. I am glad to report that research and development are closing the publicity gap evident in 1895, but I still advise that many popular accounts of the fuel cell be taken with a grain of salt.

There are many problems to be solved -- mostly problems of an engineering nature -- before you can make an operable battery.

The chemical engineering problems involved in getting from cells to batteries are closely interrelated. You can begin, for example, with current density. In all these devices, the voltage drops off as the current density increases. If you decide to fix the current density, you have fixed the voltage, assuming other conditions constant. When you have fixed the voltage and the current density, you have fixed the efficiency. When you have fixed the efficiency, you have fixed the amount of heat to be rejected, because what you don't take out as electrical work must come out as heat.

But that is not all. Current density is translatable into rate of reaction. So current density is related to mass transport -- and mass transport accomplishes heat transport.

Obviously what you have here is a whole complex of interrelated chemical engineering problems that have got to be solved before you put a battery to work.

The first significant use of fuel batteries will be in the Gemini spacecraft. Gemini, of course, is the two-man orbital mission for which the General Electric Company's Direct Energy Conversion Operation is providing a two-kilowatt power source that operates on hydrogen and oxygen. The power source itself weighs less than one astronaut and does the work of 2000 pounds of conventional batteries. It began with the invention of the ion-exchange membrane fuel cell by Dr. W. Thomas Grubb and its further improvement by Dr. Leonard W. Niedrach. To make the fuel battery for Gemini successful, the Direct Energy Conversion Operation had to solve all the chemical engineering problems I have just mentioned. One that was solved in most ingenious fashion was the mass transport of water.

The fact that these cells do produce water which the astronauts can drink is one of the advantages of the design. This water is carried

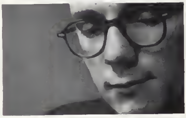
(Continued on page 22)

Dr. Herman Liebhafsky, manager of the Physical Chemistry Section, has been on the staff of the Research Laboratory since 1934, and for the last decade has been intimately connected with fuel cell research. With Dr. Elton Cairns as co-author, he is in the process of writing a book on the subject, which will be published by Wiley and Sons under the title "The Fuel Cell--Its History, Scientific Basis, and Possible Applications."









Two fundamental answers from IBM

What is "data processing"?
Simple arithmetical or logical operations done at extremely high speed by a computer. The large-scale IBM 7080 system has the capability of performing 76,000 additions or making 303,000 logical decisions per second.
A data processing system can find one fact in a million or calculate an answer, using millions of separate facts—both at electronic speed.

What does data processing promise you?
Let's reason for a moment in parallels. Add a gas engine to a cart: 80,000,000 automobiles on our roads today. Add Roman candles to a kite: New York-London jet schedules are now at 6½ hours. Add computers to dictionaries: instantaneous communication among peoples of many tongues. And, like drivers and pilots, men will run these computers for our general benefit.

What are some current projects at IBM

Designing computers that are so small and light that astronauts can use them for rendezvous in outer space.

Utilizing a thin film of metal alloy to hold the magnetized "memory" of a computer—film as thin as 500 to 2,000 angstroms. (The wave length of yellow light is 5,000 angstroms.)

Processing photographic information with computers to study contours—even the shapes of clouds.

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TECH NEWS

LASER TRACKING SYSTEM DEVELOPED BY WESTINGHOUSE AIR ARM

An experimental optical-frequency tracking system that performs angular tracking of laser-illuminated targets has been developed by the Air Arm Division of the Westinghouse Defense and Space Center. The system is now undergoing system and performance evaluation at the Air Arm Division plant near Baltimore, Md.

The optical-frequency equivalent of a microwave-frequency tracking radar, the system consists of a coherent optical (laser) transmitter and a monopulse optical receiver. It is capable of measuring line of sight angles in azimuth and elevation, with respect to the boresight axis, from a single pulse.

The transmitter operates at a 1.06-micron wave length using a neodymium-doped calcium tungstate laser. The laser's output is 0.1 joule per pulse and its pulse repetition frequency reaches 40 pulses per second with air as the only coolant.

A pair of diffused-junction silicon detectors are used in the receiver in conjunction with an optical encoder. These detectors provide an output whose amplitude is a function of the linear displacement of the image. An auxiliary or reference detector is used to measure the image intensity directly, and error outputs are made independent of signal strength by automatic gain control circuitry.

Many potentially lethal gases and deadly dust particles can now be safely monitored by a device developed by IIT Research Institute for Edwards Air Force Base.

Designed to detect poisonous boron compounds used extensively in NASA and Air Force rocket propulsion research, the monitor can also be adapted to measure minute quantities of other toxic or flammable vapors such as chlorinated hydrocarbons, nitrogen dioxide and petroleum fuels, according to the monitor's developer, Dr. Robert S. Braman, IITRI research chemist.

The toxic level for pentaborane, Dr. Braman said, is only 10 parts in a billion parts of air for an eight-hour period. The monitor, working continuously, will sense this level within a few seconds, providing a safety margin of several hours to those in the contaminated area.

Operating on a simple principle, the monitor pumps air through a self-contained gas pilot light. The flame is colorless until a contaminant passes; then a characteristic color is observed, in the case of pentaborane, faint green. A standard vacuum tube, called a photomultiplier, measures the intensity of green, which is then translated electronically to a meter display. An alarm switch will close when the meter reading reaches a preset point.

NONDESTRUCTIVE INSPECTION METHOD EMPLOYS CORONA MEASUREMENT

Detection of corona discharges is a useful way of locating flaws in electrical insulation, and it has now been adapted for nondestructive inspection of other materials. The inspection method uses the principle that gas-filled spaces in or adjacent to solid nonconducting materials ionize when a high voltage stress is applied across the material. The method can be applied to virtually any dielectric material and any shape of object, provided the thickness is not more than one to two inches in the region that is to be tested.

Electrodes are applied to two sides of the object, and an ac potential from a high-voltage transformer is connected to the electrodes. The voltage is adjusted to the level required to ionize the gas in any voids in the material. Ionization of the gas in a void causes pulses of high-frequency current in the high-voltage circuit. These pulses are amplified and measured by a detector circuit connected to the high-voltage circuit.

The Corona Inspection Method detects hidden defects such as this one (revealed by sectioning a structure of rubber bonded to metal).

The latter approach has been used successfully to locate flaws in structures made of rubber bonded to metal. Two types of flaws were present -- gas bubbles within the rubber and lack of bonding between the rubber and metal inserts. (See photograph.) The inspection process was automated by programming the movement of the small scanning electrode and by applying the signals from the detector circuit to a recorder that mapped the location and size of defects.

INDEX OF ADVERTISERS

The Complete Engineer

by Erling Jacobsen

I quickly tire of people who continually seek an engineering difference between male and female engineers!

Our profession is pursued by those who are technically qualified to make it the expanding and productive field it is. Men and women so trained and employed are all engineers. However, the increasing presence of women in engineering and applied science has caused a marked feeling of uneasiness. This is not only true among the men -- probably the women feel this even more strongly. Assuming both men and women may have equal technical capabilities, the problem reduces to the following: Neither sex knows how to behave in the presence of the other when there is a mutual technical interest.

We have a tendency to identify polite social behavior as a female quality with its essentially female outward evidences (a neat home, flowers in the office, etc.). However, a more accurate and revealing definition relates politeness to a set of customs adopted by civilized men to enable them to get along, each with the other. It is equally binding on men as on women. Being concerned how men and women engineers get along with each other, I believe it important to review some of these customs to show how simple the relationship really is. The following rules of behavior apply not only to engineering, but, of course, to any field in which men and women have similar responsibilities.

An engineer is courteous. He or she respects the other as a person. No truly polite and considerate person finds it uncomfortable to accord the courtesy due others by virtue of their position or sex. It is utter nonsense to expect the female engineer to "become a man" when she enters the office. The woman who could would be a strange person indeed. The woman who tries is ridiculous -- a person with whom no one feels particularly comfortable.

By the same token, no man should act as if he expected her to be a man. He loses his gentlemanly qualities and becomes just as uncomfortable to be with -- even among men. A cocktail-party over-attention by either of the sexes should, of course, also be avoided. Just be naturally courteous -- a most simple requirement.

An engineer is diplomatic. It requires experience to determine the circumstances under which engineering "straightforwardness" is considered rude and out of place. I do not advocate a "wishywashy" approach. In any technical discussion engineers must sell their ideas in order to make a contribution to the job at hand. It is futile, however, to negate what might be a valuable contribution by an ill considered presentation.

This brings to mind a meeting I once attended. No conclusions had been reached after many hours of deliberation. Suddenly, one of the participants stood up and said, "Oh, let's think! Any fool can see that...." He was right; we had missed the interrelation of certain factors. However, the fullest impact of his logic was irrevocably lost by the manner in which he presented it. In those few disparaging introductory words he insulted and humiliated everyone present.

The more sure you are that you are right, the more carefully should you consider how to present your opinions. After all, most engineers do not arrive at their opinions in a haphazard way. They have a personal pride in their conclusions. In this respect, women engineers have, unfortunately, a tougher hurdle than men. It is generally conceded, even among women, that many women have the tendency to give snap judgments more often than men and to have opinions on a wide range of subjects on which they are unqualified to judge. Therefore, without minimizing her contribution, the woman engineer should be particularly sensitive to this in the presentation of her ideas. She must use just that much more diplomacy -- at least until her professional reputation has been firmly established.

An engineer is appropriately dressed. This simply means that the engineer is attired in a manner appropriate to the task at hand. It is generally agreed that professional people are expected to observe some conservatism in dress. It is unbecoming for either men or women engineers to wear extreme styles at work. On the other hand, although a business suit is advisable for the office, it would usually be considered pretentious wear if the engineer were engaged in a field or, perhaps, laboratory project.

Your appearance should reflect what you want others to believe are your capabilities. Again, this requirement is easily met by sensitive people. It is mentioned here only because its observance puts people at ease. Engineers occupy an increasingly more important position in society, and we should remember there are still people who feel that engineers are sloppy and uncouth. First impressions will do much to overcome that opinion.

This brings me to my last point -- that of professional pride and professionalism in general.

Above all, an engineer is professional. A quick glance at the "Code of Ethics" for engineers tells all that is meant by this phrase. Insofar as our general topic is concerned, we must remember that it implies the professional respect that one engineer gives another. It implies, further, the personal responsibility we each have, as engineers, to uphold our profession by our behavior. Ours is a proud profession -- an honorable calling. It asks for and should receive the best that each of us can give.

Think of some of the engineers for whom you have particularly high respect. Look upon them as being something more than technical experts. Regard them, rather, as being persons who because of your high esteem represent the best of engineering to the world. It is likely that most of these persons rate high in courtesy, attire, diplomacy and professionalism. Pause for a moment to consider them in this light.

Then -- very carefully -- consider yourself in the same light.

immediately, the victim may be revived. (There is hope in this world, I tell you...)

For Currents Well Above the Ventricular Fibrillation Current:

Thermal burns. The body temperature increases very rapidly and immediate death may occur if the victim is not fortunate enough to be thrown immediately out of the circuit by the violent muscular reaction which takes place. (This is one place where it's a pleasure to be kicked out.)

Electrocution of criminals is accomplished by very high currents, and death occurs as a consequence of the sudden rise in body temperature.

Now you know all there is to know about building a better chair (electric, that is). There may be a market for it. Just think:

To punish criminals of criminality,
Don't boil them with common electricity,
But please kill them with finesse and subtility
The ventricular fibrillation current way.
(Pronounced "wee" ... so it will rhyme.)

We could, by this process (...patent pending), gather more complete, valuable data about the effects of electrical shocks on humans, and save the innocent lives of the hundreds of cats, dogs, and sheep, etc...that are now used for this purpose — at the same time we could also save electricity.

Well, it was an idea... In the meantime, remember this: Be extremely careful when working with or around electricity. Low voltages, as well as high voltages, can cause death!

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MECH MISS

"She's the sweetheart of THETA TAU"

Larchmont, New York, 1944—Mr. and Mrs. Borneston are the proud parents of a lovely blue-eyed, brown-haired girl.

Larchmont, New York, 1963—HOMETOWN GIRL SUCCESS ON CAPITOL HILL.

Little Kathleen "Missy" Borneston, the 5' 3½" beautiful young lady who hails from our fair town is now a successful college coed in the Nation's Capitol. Currently a sophomore, majoring in Business Administration, at The George Washington University, she occupies her spare time by taking an active part in her sorority, Delta Gamma, where she was secretary of her pledge class, and later, assistant pledge trainer.

She is still pursuing her interests in music by continuing to play the piano, and by participating in the Messiah Chorus at G.W.U. And, to round out her college life, she is an active member of the Horseback Riding Club.

Our congratulations to you, Missy, and we all (including the Engineers) wish you the best of luck and good fortune in the coming years.

Assignment: design a car for tomorrow... that could be built today!

Result: Allegro, an experiment in advanced automotive ideas that are practical for the near future

Allegro means "brisk and lively," which certainly describes Ford Motor Company's new dream car, a handsome fastback coupe. More than that, Allegro has unique functional features that could be adapted for future production cars. (This has already occurred in the case of retractable seat belts!)

A major innovation is a cantilever-arm steering wheel with an electronic "memory." The steering wheel is mounted on an arm that extends from a center-mounted column. The wheel swings upward for easy exit, returns automatically to its former position at the touch of a button. Power adjustment enables it to be moved three inches fore and aft and five inches vertically. This, plus power-adjustable foot pedals, permits use of a fixed seat design for low overall height.

Basically a two-seater in present form, Allegro has rear floor space that could be converted to carry two additional passengers. The car could be powered by either a V-4 made by Ford of Germany or by the domestic 144- or 170-cubic-inch Sixes.

Allegro is one of a series of Ford-built dream cars which will be shown at the New York World's Fair to test consumer reaction to styling and mechanical innovations. This will help determine which of their forward-looking features are destined for the American Road—as further examples of Ford Motor Company's leadership in styling and engineering.

Ford

MOTOR COMPANY

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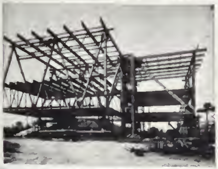
What's new at Bethlehem Steel?

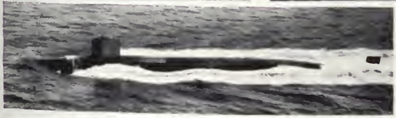
New $40-million research laboratories in Bethlehem, Pa.

Building a $250-million steel plant at Burns Harbor, Ind.



Fabricating and erecting steelwork for World's Fair structures, including the magnificent Federal Pavilion.

Producing thin tinplate on the nation's newest tin mill, at Sparraws Paint, Md.



Official photograph U. S. Navy

Building nuclear-pawered submarines at Quincy, Mass.

Installing new axygen steelmaking furnaces at Lackawanna, N. Y.

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by wicking from the batteries to an accumulator. The arrangement has no moving parts and operates well in a gravity-free environment.

From a chemical engineering point of view, you could say that here we have a system in which we carry out a chemical reaction electrochemically, generate electricity, generate heat, and generate drinking water. The interactions that are implied constitute part of the complex task of bringing fuel cell power from the laboratory to the production line.

THE REQUIREMENTS OF A FUEL CELL

Let us turn from these engineering considerations to the problems of individual fuel cells, hydrocarbon cells included. What about reactivity? As reaction products, we want only carbon dioxide and/or water. This is because these are the products of minimum energy, so that with them we're throwing away as little energy as possible. Then too, if you only have to worry about these two products, rather than many, the system is relatively simple. You also want high and unimpeded electrode reactivity, since the rate of the electrode reaction determines the current density that you get.

In addition to this, you have the invariance requirement: no change in electrodes or electrolyte. This looks simple, but the word conceals a great many headaches. Of course, you don't want your electrodes to corrode away, but -- if you're using a liquid electrolyte -- you don't want them to fill with liquid, either. This is known as "drowning," and if it happens, the current density goes way down...

Another way of formulating the problem is to assume that we are given five parameters: electrocatalyst, electrode structure, electrolyte, fuel, and temperature. For these we have to establish four things: the current-density/voltage relationship, the completeness of oxidation, the conversion per pass, and the life. These last four must all be satisfactory before you can honestly say that a fuel cell is ready to leave the laboratory. And, if you change any one of the five parameters, you'd better re-establish the other four.

The current-density/voltage relationship, of course, is vital, and we have already referred to the completeness of oxidation in mentioning the desirability of going to water and carbon dioxide. Conversion per pass is also extremely important. Some people in this business have been known to run fuel through a fuel cell at a simply frightful rate, thus converting perhaps not more than a few per cent of the fuel, and then saying that they had a fuel cell. That, of course, is impractical. If you do anything like that, you are wasting most of your fuel. If you don't want to waste it, you've got to put enough cells in a row to use it up, and that will simply boost your capital costs until they become intolerable. The importance of our last parameter, life, is self-evident.

Let's look at the fuel. Hydrogen is in a class by itself as a fuel, because it is so highly reactive. A molecule of hydrogen will give up only two electrons, and it's got no place to go except water, or what's equivalent to it -- hydrogen ions. On the other hand, cetane -- a relatively simple hydrocarbon molecule -- will give up almost a hundred electrons. Furthermore, you can't take them off all together: you probably have to take them off one at a time. (We're not sure.) This gives us an almost infinite possibility for complications. Actually, to oxidize the cetane, you've got to bring in combined oxygen from the electrolyte, and when you set yourself the mathematical problem of how many compounds can be made with cetane as the parent, with oxygen added, the number comes out to be thousands.

If you get these compounds, obviously you don't get complete oxidation, and your efficiency suffers. Worse than that, if some of these compounds remain on the anode, they could block further reaction there. The hydrocarbon problem, when you look at it this way, is really staggering. Let me remind you that cetane is the kind of hydrocarbon that serves as a model for kerosene or for diesel oil.

What has to happen at the anode in a hydrocarbon fuel cell? There must be the adsorption of fuel, the breaking of bonds, the transfer of electrons, the removal of reaction products, and the transfer of combined oxygen from the electrolyte. The first three processes don't seem to be any problem, the next may be, and the last promises trouble. Here you must bring in something analogous to oxide ions from the electrolyte in order to build the various intermediate products that you need before you can convert, let's say, cetane into CO_2. This is likely to be the slow step in this very complex process.

Let me now discuss what is, in principle, I think, the most elegant of all possible fuel cells.

THE ZIRCONIA HIGH-TEMPERATURE CELL

This is a new fuel cell using a solid electrolyte, in contrast to earlier high-temperature

cells, in which liquid or molten electrolytes have been used. We have found that several materials, all based on zirconia, and most commonly doped with calcium oxide, are suitable for this purpose. They have vacancies in the anion lattice, and the current transfer is almost entirely by oxygen ions. The electrolyte ought to remain invariant, and fortunately we have found that it does. Unfortunately, no substances are known which have good conductivity at low temperature. If, in my judgment, somebody could find an electrolyte of this kind which had adequate conductivity at 700°C -- or perhaps, even better, at 500°C -- I think this type would be the most promising fuel cell in the business.

All right, let's say we can't have that. Let's say that we've got to make do with the present electrolytes, which have to be operated at 1000° to 1200°C. Now what are the limitations? Well, first, thermodynamics is against you. The formation of carbon is always a threat, in any type of fuel cell using carbonaceous fuel. If you form carbon at the anode, you will not go to carbon dioxide, and you may not go to water.

In one version of the Metallurgy and Ceramics Research Department fuel cell (see page two), this drawback is turned to advantage. Methane is fed in, oxidation takes place, you get hydrogen and carbon monoxide, and you get an anode formed for you from the carbon that is deposited from the methane.

Perhaps the most serious problem in this type of cell is satisfactory electrodes. The carbon is fine. While evaporation limits the life of a molten silver cathode, design innovation has extended silver cathode life. Another novel approach has been to use electronically conducting oxides as cathodes. Work is continuing to determine the range of applicability of these new cathodes.

A HAPPY MARRIAGE

Now we come to the recent work of Grubb and Niedrach. What you have here (see page two) is the happy marriage of electrode and electrolyte which makes it possible to obtain quite good performance from a saturated hydrocarbon fuel at less than "cake-baking" temperatures: from 150° to 200°C. By "good" performance I am referring to half a volt and 20 milliamperes per square centimeter at 150°C -- roughly 10 watts per square foot. I think that at 200°C you can do roughly twice as well.

This performance, of course, is highly gratifying. But I think that is not the main importance of the work. The main importance of the work, the keynote here, is simplicity. So far as we know, you always get carbon dioxide and water from the fuel consumed -- complete oxidation. This means that at one stroke Grubb and Niedrach have been able to show that you don't have to worry about the complexities that I talked about when I described cetane. That's an extremely important result.

A second important result -- and to anyone in the fuel cell business, this comes as a blockbuster -- is that the various saturated hydrocarbons give the same current density at 0.2 of a volt (within an order of magnitude). Now, 0.2 of a volt is not a practical operating voltage. It simply is a voltage that Dr. Grubb picked as a convenient reference point. But, a sacred cow in this business has been that methane is fantastically inert. You can get nice explanations for this based on high symmetry of the molecule, carbon atoms each surrounded by four hydrogens, all symmetrical, but the explanations don't hold water here. Methane does react and reacts quite well.

There are, however, some problems which arise in such a fuel cell, not the least of which is the high cost of platinum, and the corrosiveness of the phosphoric acid at elevated temperatures.

I have told you only a small part of the fuel cell story. The difficulties are formidable; the possible rewards are big. The end of each year has seen us further ahead than we might logically have expected. The work must continue -- as Ecclesiastes has it, "There is no discharge in that war."

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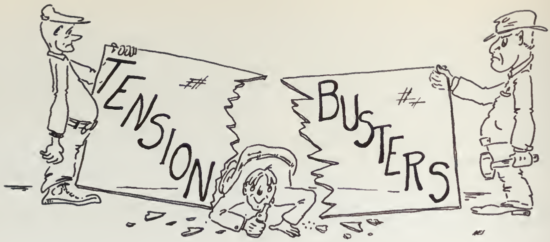


Notice on the bulletin board of the zoology department:

"We don't begrudge your taking a little alcohol, but please return our specimens."

* * *

The weird scientist looked over reports on his life-preserving tonic.

"Hmmmmm," he mused, "I see where my elixir has had its first failure--a ninety-eight-year-old woman. Ahhhh, but what's this? They saved the baby."

* * *

Political definitions:

Socialism—You have two cows and give one to your neighbor.

Communism—You have two cows; the government takes both and gives you the milk.

Fascism—You have two cows; the government takes both and sells you the milk.

Nazism—You have two cows; the government takes both and shoots you.

New Dealism—You have two cows; the government takes both, shoots one, milks the other and throws the milk away.

Capitalism—You have two cows; you sell one and buy a bull.

* * *

A Texan, newly arrived in England, was playing poker with a couple of the natives. He was pleasantly surprised upon picking up an early hand to see four aces in it.

"I'll wager a pound," said the Britisher on his right.

"Ah don't know how y'all measure yore money," drawled the Texan, "but Ah reckon Ah'll have to raise you about a ton."

Noah was standing at the gangplank of the ark giving instructions to the pairs of animals as they left. When two adders came along he said, "Go forth and multiply."

"But we're adders and don't know how to multiply," they replied.

"Then go forth and seek the mysteries of multiplication," Noah instructed.

After the last pair of animals had left the ark, Noah and his family ventured forth unto the land. Sometime later he stumbled over a pile of logs and on looking down discovered the pair of adders and several little adders secluded among the logs. "I see that you have discovered the secret of multiplication."

"Yes," hissed one of the snakes, "we found that it's easy for us adders to multiply by logs."

* * *

"Oh, doctor," the young lady asked, "will the scar show?"

"That, madam," said the doctor, "is entirely up to you."

* * *

How do you catch an elephant?

Dig a hole in the ground, fill it with ashes, and line the rim with peas.

When the elephant comes to take a pea, you kick him in the ash hole.

* * *

1st Farmer: Now that your son is back from G.W.U., do you notice any difference in the way he plows?

2nd Farmer: Not in the way he plows, but in the way he talks.

1st Farmer: How do you mean?

2nd Farmer: Well, when he gets to the end of a row, instead of saying, "Whoa, Hawse," he saws", Halt Rebecca. Pivot and proceed."

A farmer and his wife lived happily, but for one thing: the wife was very particular about the language her husband used.

One evening, the farmer arrived home and announced, "I've invited my friend Bill over for dinner." His wife immediately replied, "Don't call him Bill, call him William."

The next evening, the farmer turned to his friend and said, "I would like to tell you a tale." His wife quietly whispered "Not a tale, an anecdote."

That night, upon retiring, the farmer asked his wife to put out the light. Curtly, she retorted, "NO! I will not put out the light, I will extinguish it."

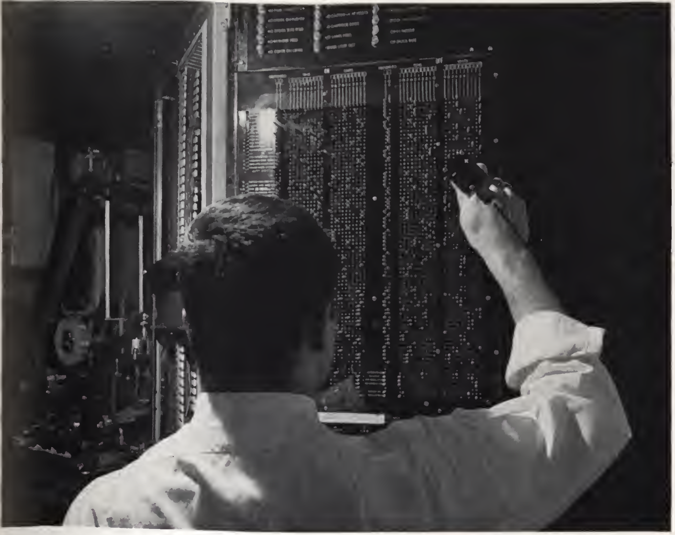
Later in the night, the farmer's wife heard a loud disturbance. She awakened her husband and sent him downstairs to investigate. A few minutes later, he returned, and she inquired as to the nature of the commotion.

The farmer replied carefully, "It was a Williamgoat which I grabbed by his anecdote and extinguished."

* * *

How do you carve an elephant out of a stone?

You chip away everything that doesn't look like one.



TURN OUT THE LIGHTS AND PRESS THE BUTTON

No preconceptions, please. Too often they point you away from the buried treasure. Because Kodak is properly known as a grand place for chemical engineers and chemists, fledgling electronic engineers may overlook us. All the better for those who don't. Particularly for those who would rather apply ideas than dream them, unfashionable as candor compels us to sound.

It takes all kind of electronic engineers to make today's world, but we think we clearly see the ones likely to wind up nearer the helm here 25 years hence:

When his projects are evaluated, he'd rather be right than ahead of his time.

He works few if any miracles with sealing wax, old shoestring, and new developments in plasma harmonics, but when they turn off the lights in the big darkroom, his machine from the very first crack starts inspecting, processing, or otherwise handling light-sensitive product smoothly, bugless, and at the miraculous rates he had promised in the preliminary design report. He accomplishes this by keeping abreast of the state of his art instead of considering his diploma an exemption from learning anything new.

He deals with people as smoothly as with things.

He would rather put his roots down in the community where he lives than root himself in one narrow box of engineering specialization. He welcomes changes of pace more than of place.

He finds it cozy to know that if times change, our diversification leaves dozens of directions to go without fighting the cold world outside.

Care to talk to us? Above remarks apply to more than just electronic engineers.

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